Biodiesel: Fuel for Home Heating

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New Jersey
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What is Fine Particulate Matter?

- Fine particulate matter, $PM_{2.5}$, is a mixture of fine liquid or solid particles such as dust, smoke, mist fumes or smog

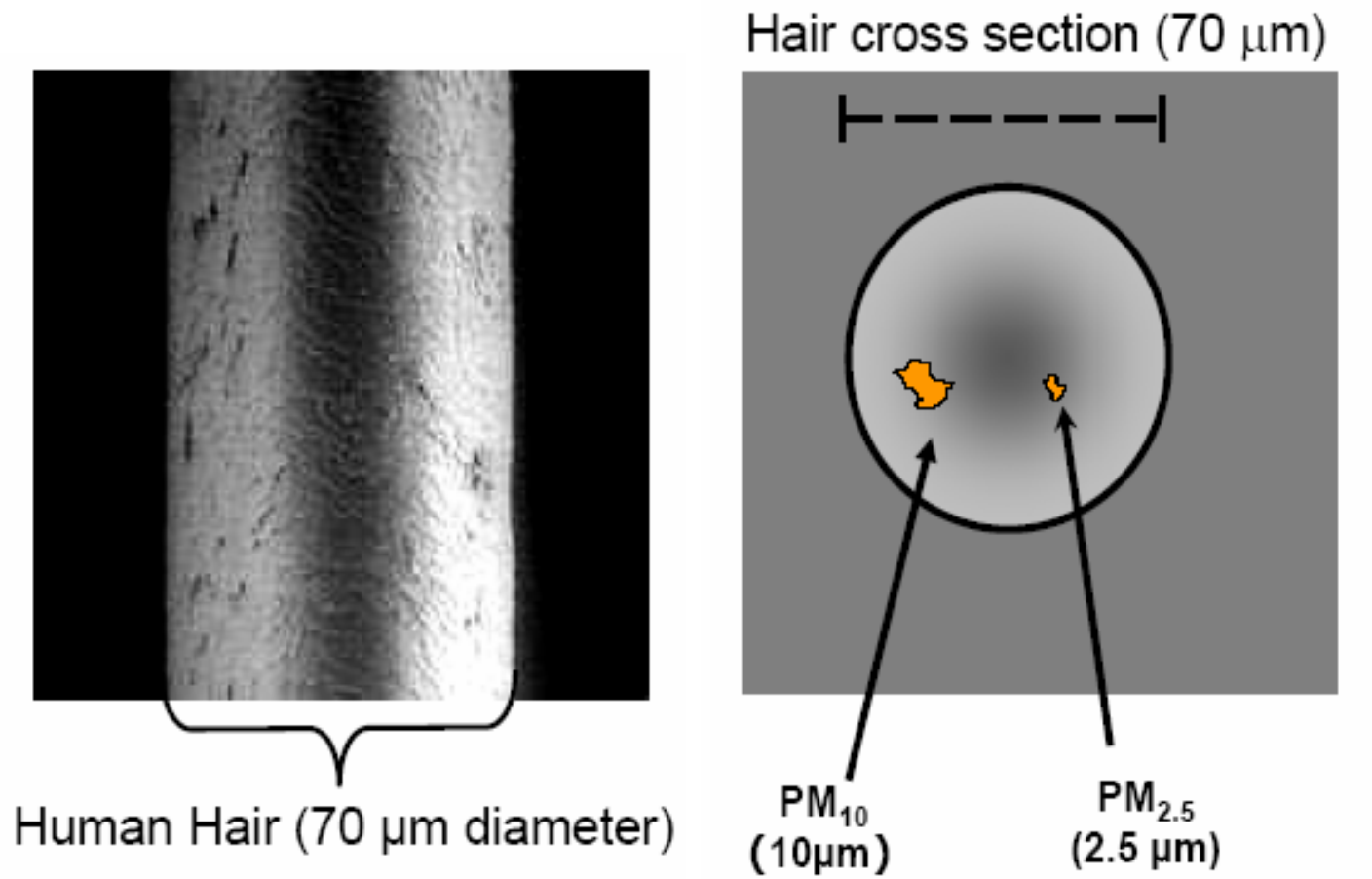
- Several thousand could fit on the period at the end of this sentence.

- Larger particles (> PM_{10}) deposit in the upper respiratory tract - the smaller, inhalable particles (≤ PM_{10}) penetrate into the lungs ($PM_{2.5}$ more so than $PM_{10-2.5}$)

Fine Particulates: $PM_{2.5}$

- Trucks, buses and off-road equipment
- The Diesel Initiative:
  - Stronger diesel smoke inspection
  - Requires retrofitting the dirty engines
  - Prohibits vehicles such as buses (school, charter, public transportation), trucks (long haul, delivery) idling and queuing more than 3 minutes

Fine Particulate Matter: What is it?



M. Lipsett, California Office of Environmental Health Hazard Assessment

Fine Particulates Health Effects

- Premature death
- Respiratory related hospital admissions and emergency room visits
- Aggravated asthma
- Coughing and difficulty or pain breathing
- Chronic bronchitis
- Decreased lung function
- Work and school absences

Achieving the fine particulate standard could save as many as

- **Premature deaths**
  - **as many as 1,900 per year**
- **Asthma attacks**
  - **53,000 per year**

The Visibility and Haze Connection to Fine Particles

- Visibility impairment is one of the most obvious effects of fine particles. It occurs at many natural parks and wilderness areas (also known as Class 1 areas)

- NJ has a protected Class 1 area located in Atlantic County - The Brigantine Wilderness Area of the Edwin B. Forsythe National Wildlife Refuge

Fine Particles:

- USEPA to propose $PM_{2.5}$ rule in 6 weeks and to be adopted next year.

Argus Air Daily

July 29,2005

What is Biodiesel?

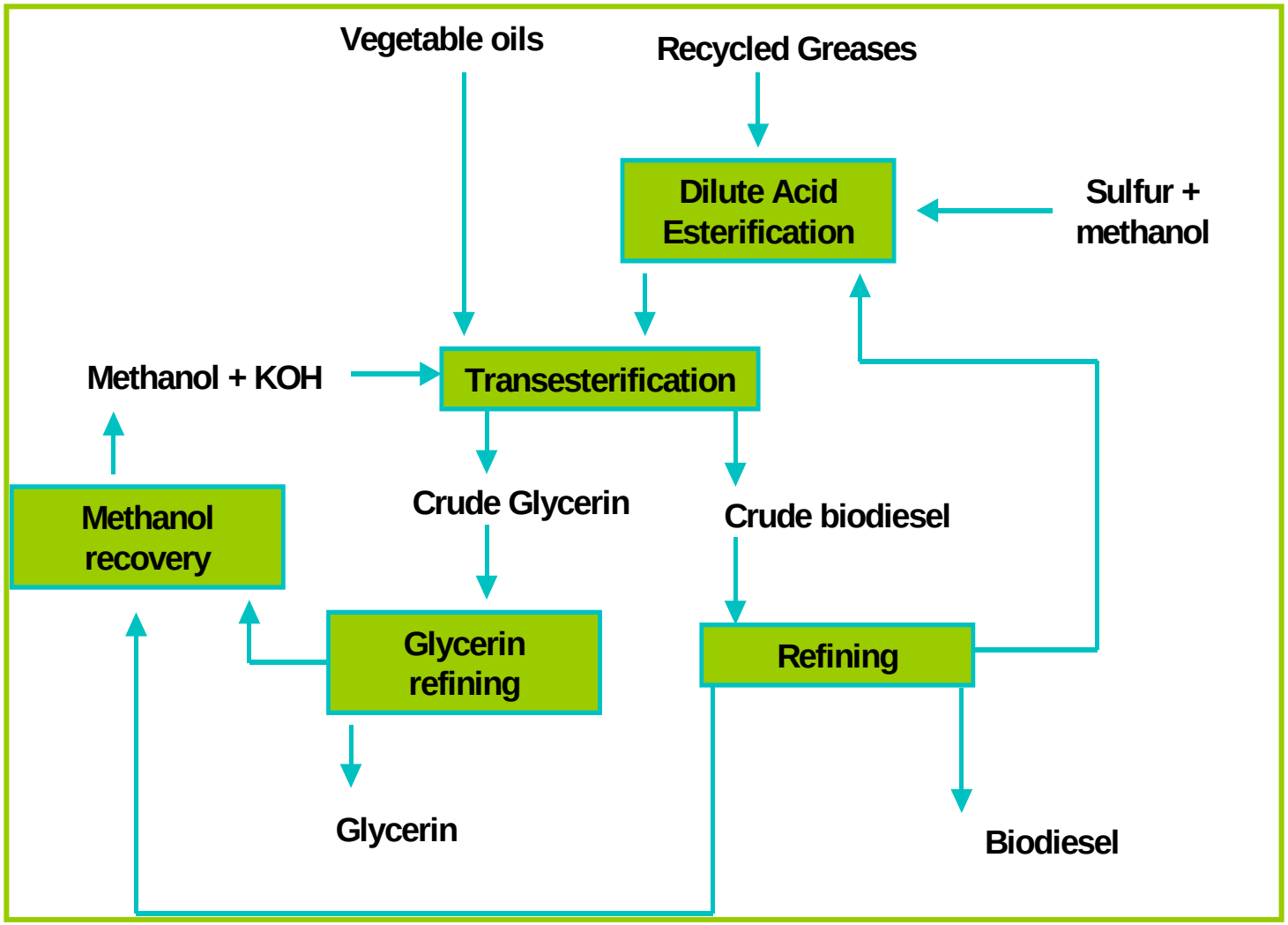
- Alternative fuel and/or oxygenate additive for diesel fuels to lower particulate matter, toxic matter and carbon dioxide emissions from:
  - On and off road vehicles;
  - Stationary and mobile power generators; and
  - Commercial and residential heating units that burn diesel fuel.

What is Biodiesel?

- Biodiesel can be produced from a variety of renewable sources:
  - Vegetable Oils (Soybeans or other crops)
  - Recycled cooking grease (Yellow Grease)
  - Animal fats (Tallow/poultry fats)
  - Grease trap waste (Brown Grease)

Basic Production Technology

Multi-Feedstock's



Biodiesel definition

- **ASTM D 6751** - "mono alkyl esters of long chain fatty acids derived from vegetable oils and animal fats"
- Biodiesel refers to the pure or neat fuel, B100
- Blends of biodiesel can be B(5), B(20), etc.

Biodiesel
Properties & Attributes

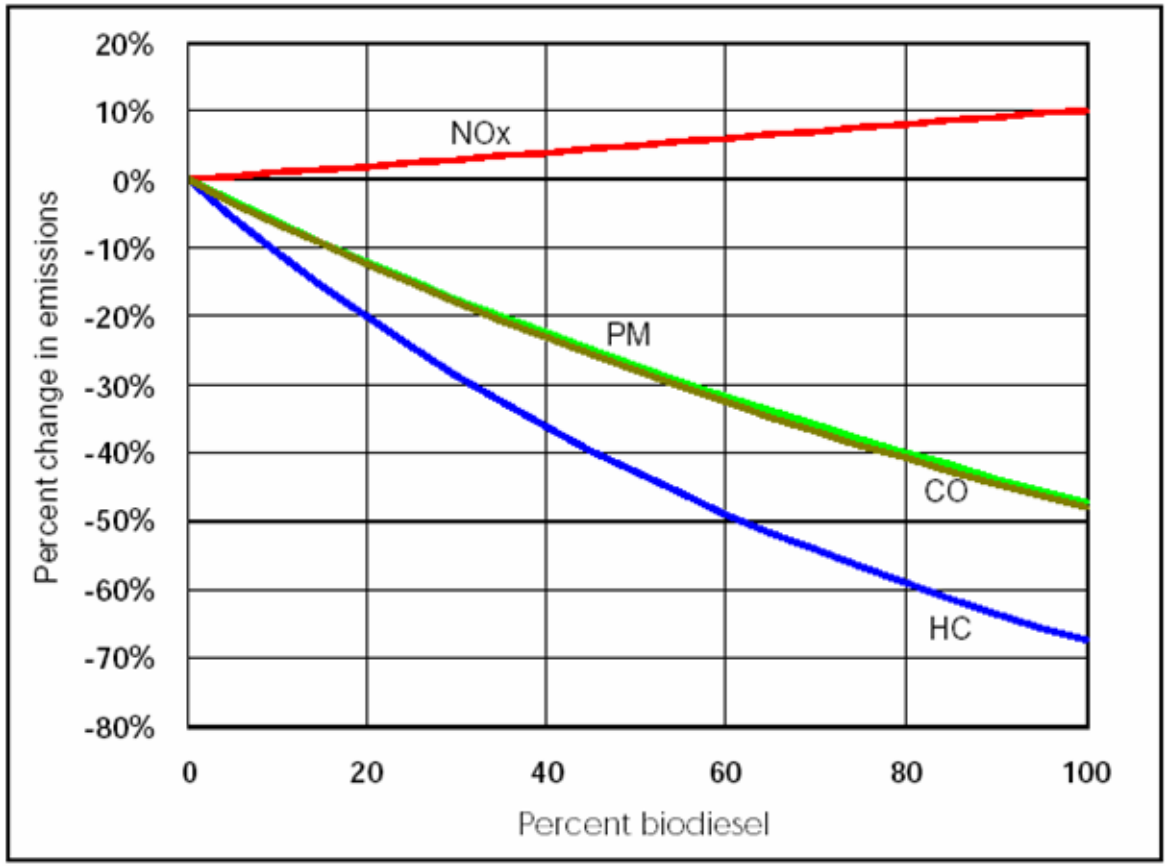
- Seamless and transparent with existing petroleum infrastructure
- Completely miscible with middle distillate fuel pool
- High Cetane (50 vs 40)
- High Lubricity (300 HFRR) – (HFRR, High Frequency Reciprocating Rig, accepted ASTM test standard)
- BTU Content (128,000 comparable to kerosene)
- Cold Flow (5-7^{o} F > for soy-based B20)
- Flash Point (>300^{oF} vs 117^{o} ^{F})
- Safety – Health Effects tests confirm it is 10x less toxic than table salt and biodegrades as fast as sugar. No nitrogen or aromatics
- Biodegradable and non-toxic
- Virtually sulfur free

Benefits of Biodiesel:

Biodiesel and biodiesel blends offer many benefits, including:

- reduced CO, HC, sulfur, PAH and PM exhaust emissions
- reduced health risks associated with diesel exhaust
- reduced greenhouse gas emissions
- decreased dependence on petroleum imports
- developing new markets for agricultural products such as soybeans.

Biodiesel Exhaust Emissions: Transportation



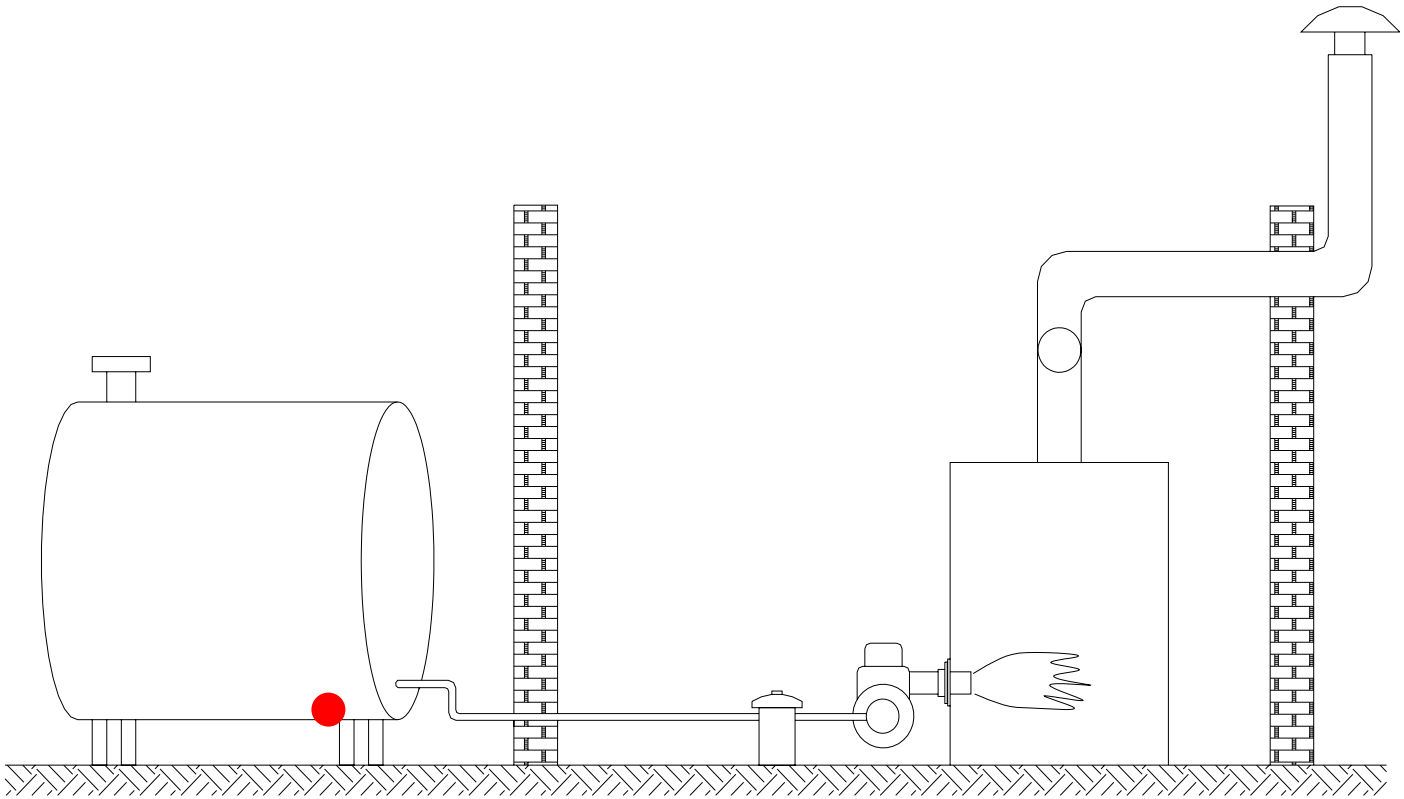
USEPA Report, Oct. 2002

Brookhaven National Laboratory Test Results

The Fuel for heating:

- Biodiesel is a diesel-like fuel
- Available from vendors now to ASTM D 6751-02
- Biodiesel is completely miscible with diesel or home heating oil (ASTM #2)
- Some Differences from #2 Fuel
  - Oxygenated by ~10% by weight
  - 8-10% higher density
  - About 10% lower heating value
  - Very low sulfur and nitrogen content

Storage Questions



Storage Stability

- Biostab – major European study on stability
- 15 month storage test – no strong change observed in quality parameters
- Oxidation does occur slowly, antioxidants (Tocopherols) have been shown to be effective
- Housekeeping – water control important

Storage:

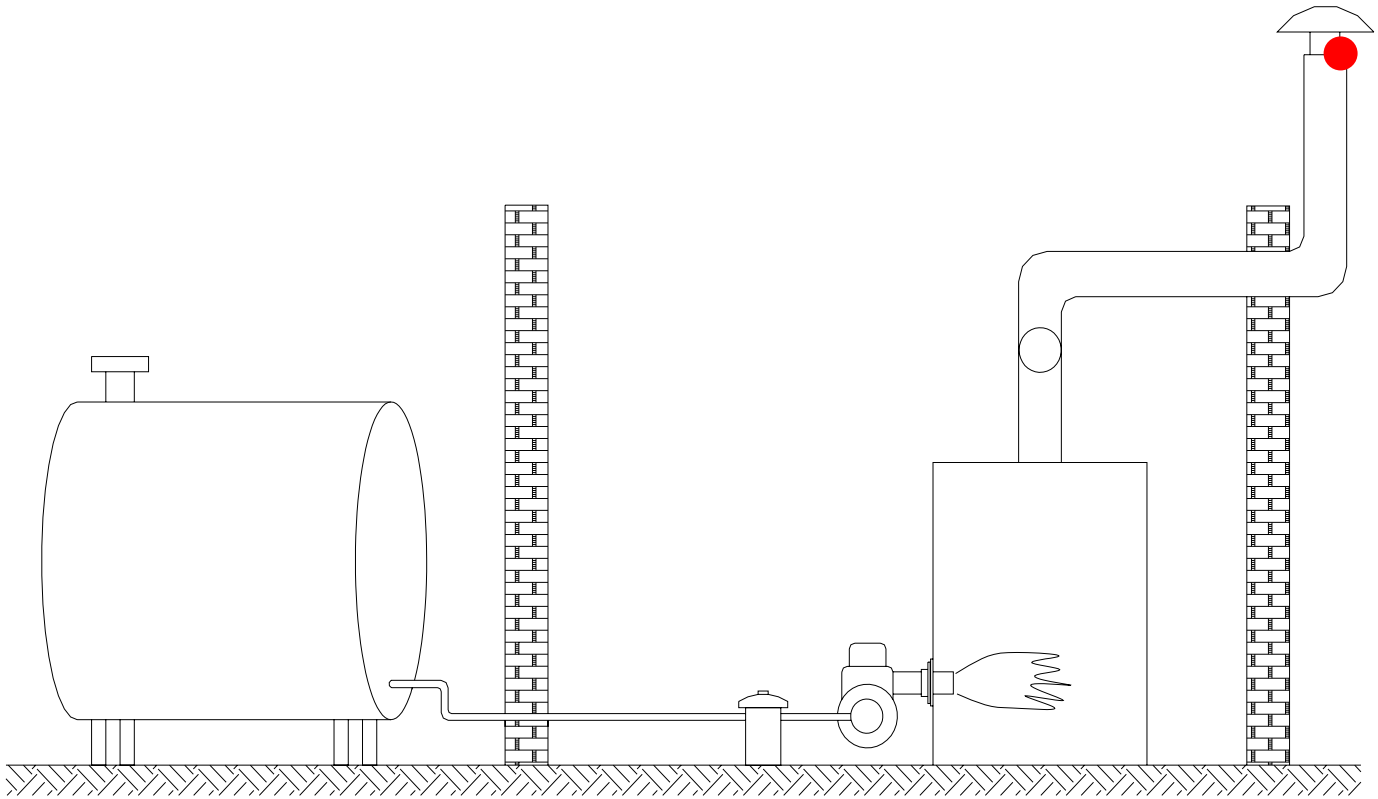
- B100 has a strong solvency effect
- B20 is not a substitute for tank cleaning
- Copper systems can experience accelerated degradation and sludge with B100
- Biocides effective with #2 oil should work with biofuels
- Storage in general for 6 months recommended – similar to #2 oil

Fuel Pumps

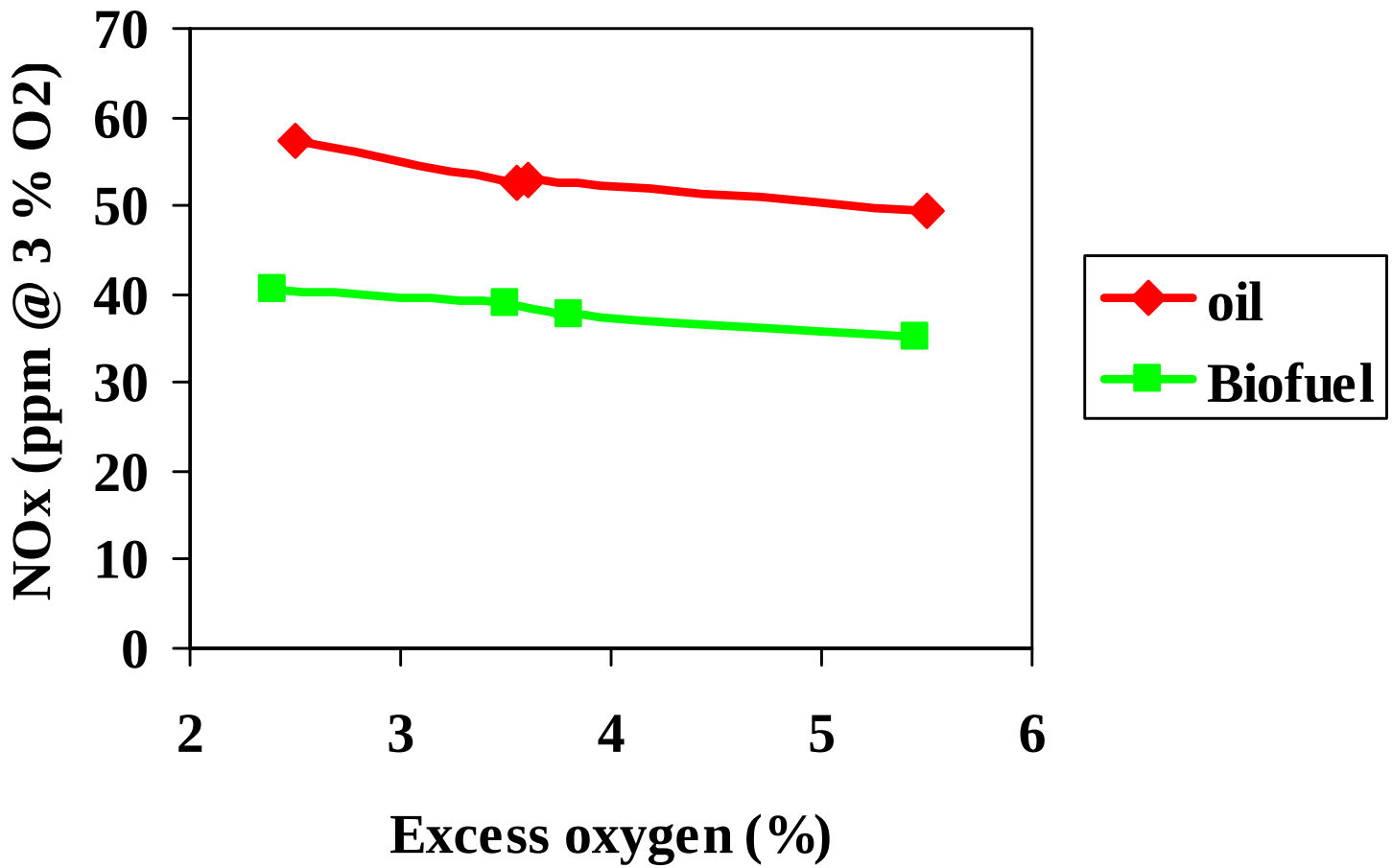
Seal materials currently nitrile. For high blends may need to change to Viton. Available in Europe.

Buna N, natural rubber also bad with B 100

Emissions



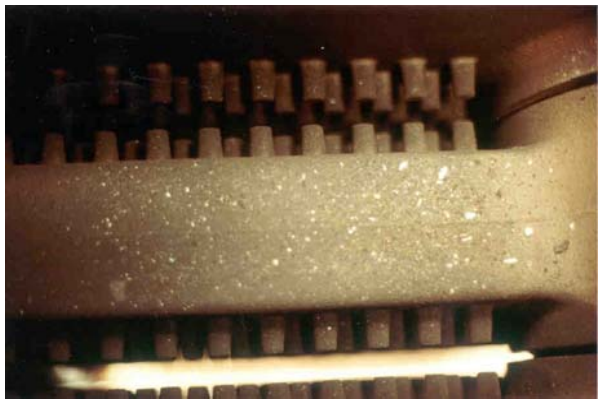
NOx – low emission burner



Field Trials

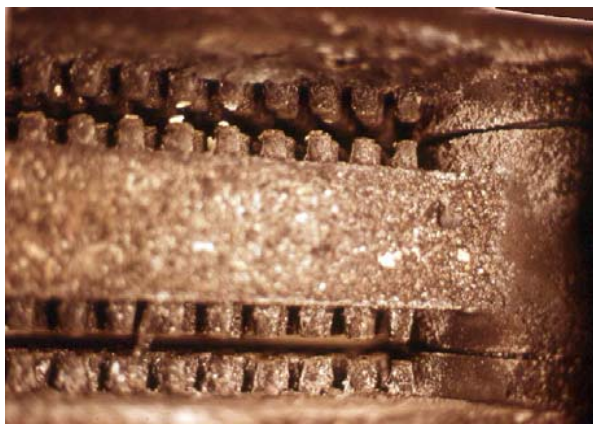
- Three year, 100 homes B 20 with Abbott and Mills. Included limited B 100 test
- Field tests with National Park Service – started Fall 2004.

Sulfur Impacts on Boiler Fouling

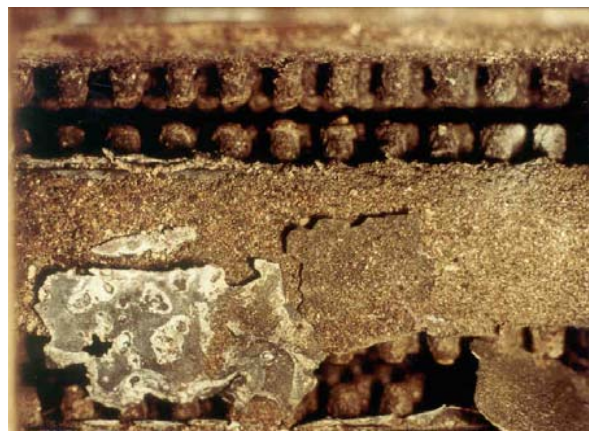


No.2 heating fuel, 0.04% Sulfur by weight

No.2 heating fuel, 0.18% Sulfur by weight

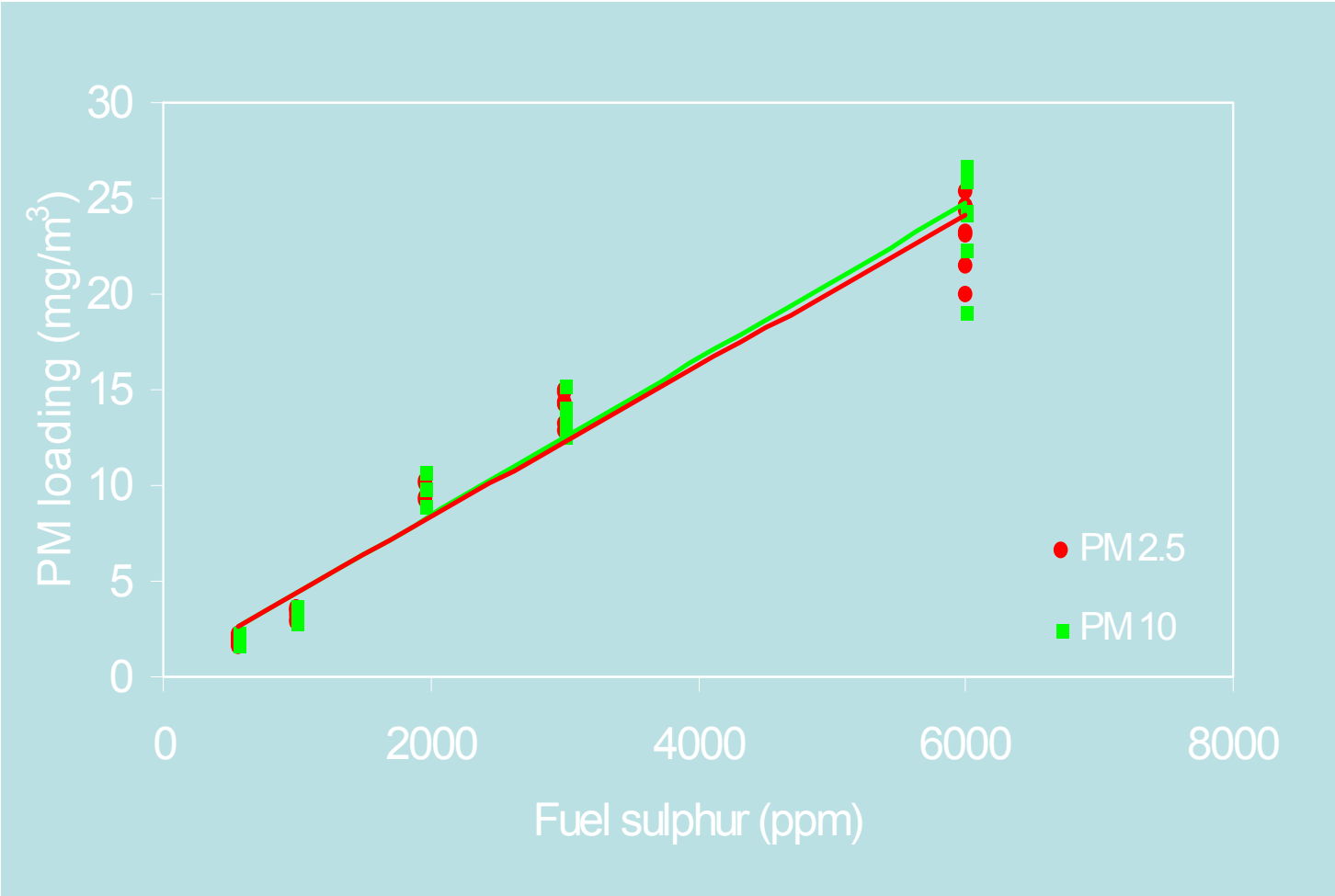


No.2 heating fuel, 0.34% Sulfur by weight



No.2 heating fuel, 1.08% Sulfur by weight

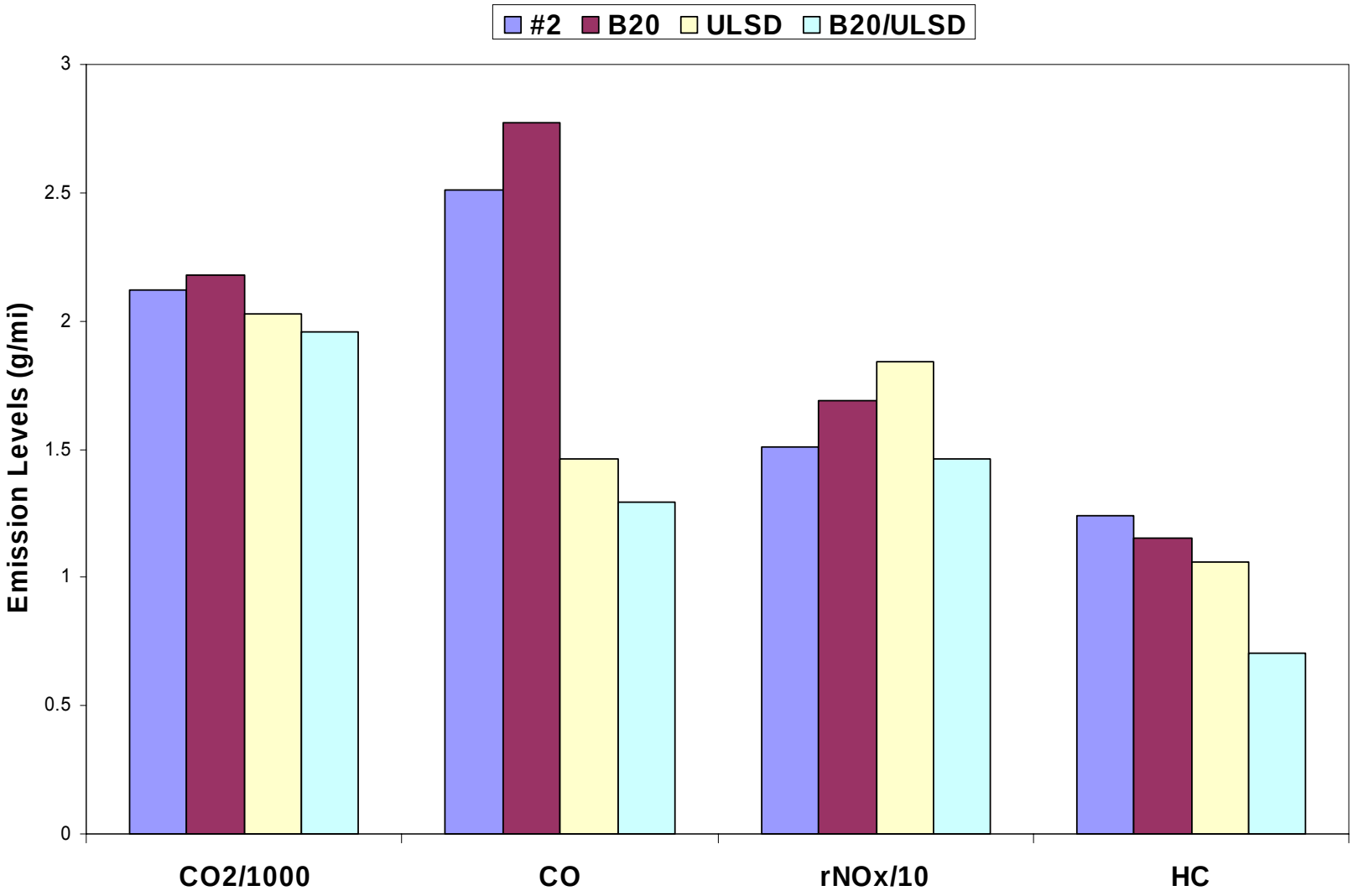
Sulfur Impacts on PM 2.5



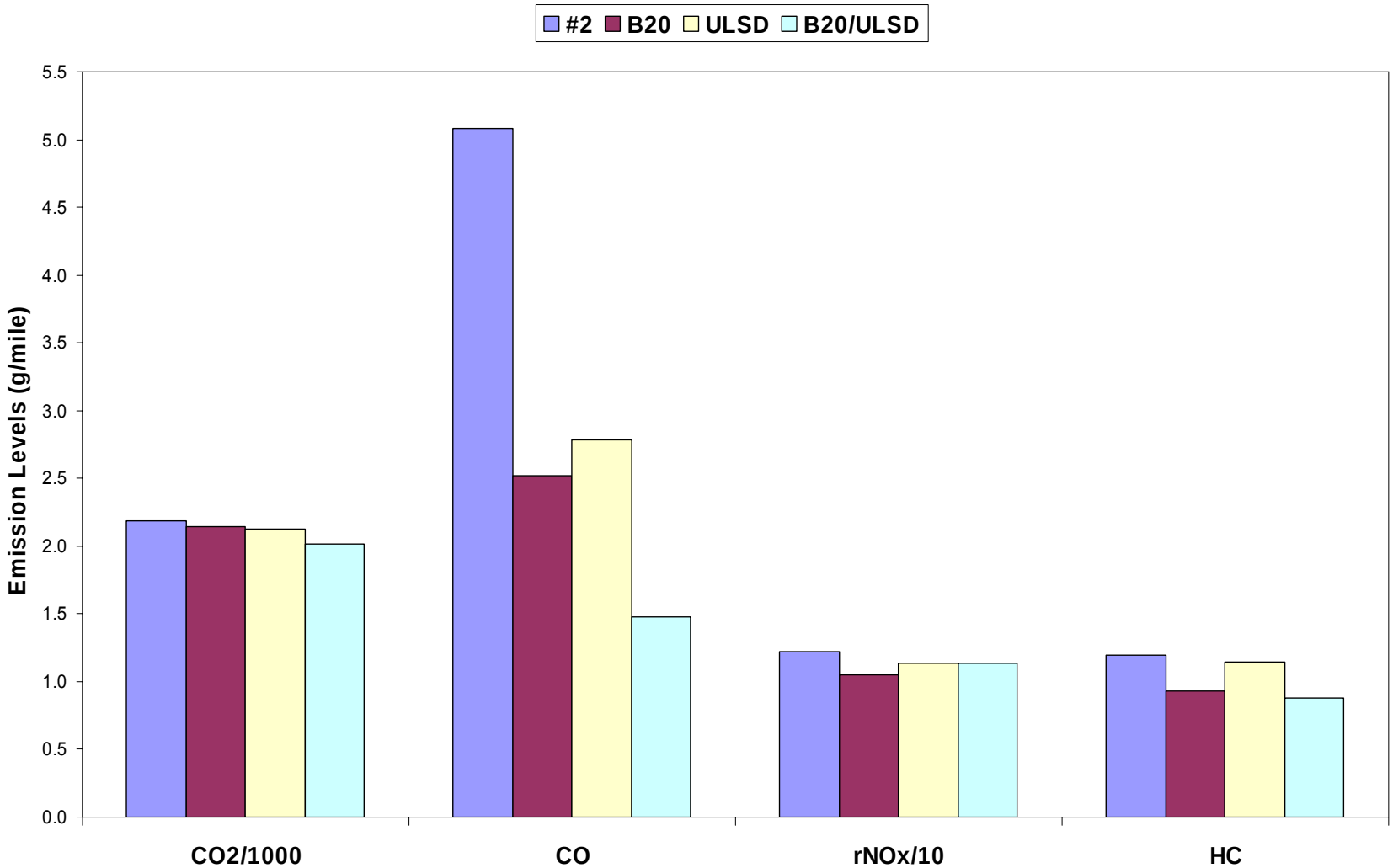
Source: S. W. Lee, Canmet, Ottawa

Rowan University Biodiesel Test Results:

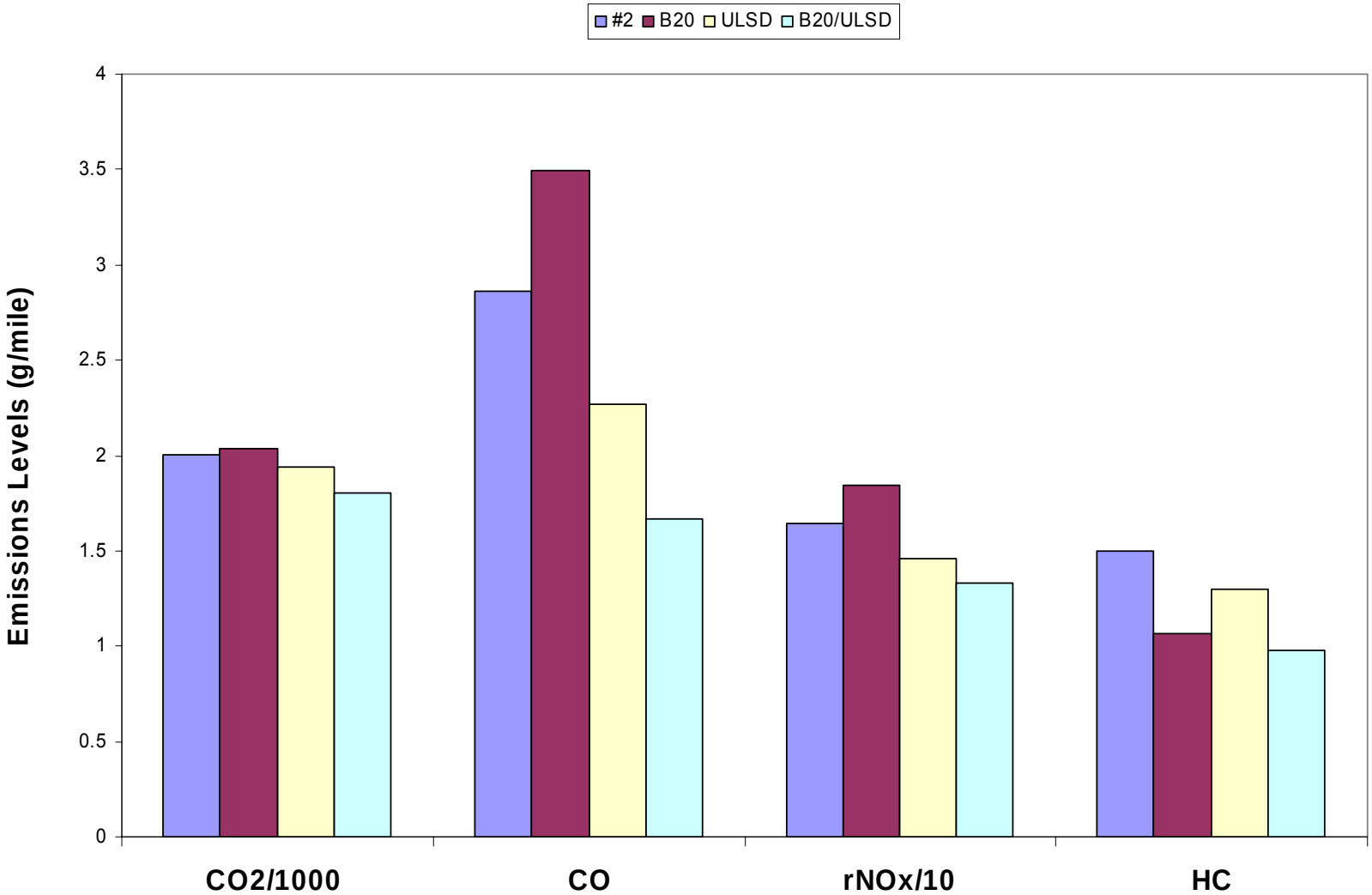
Fuel Results – DT466E



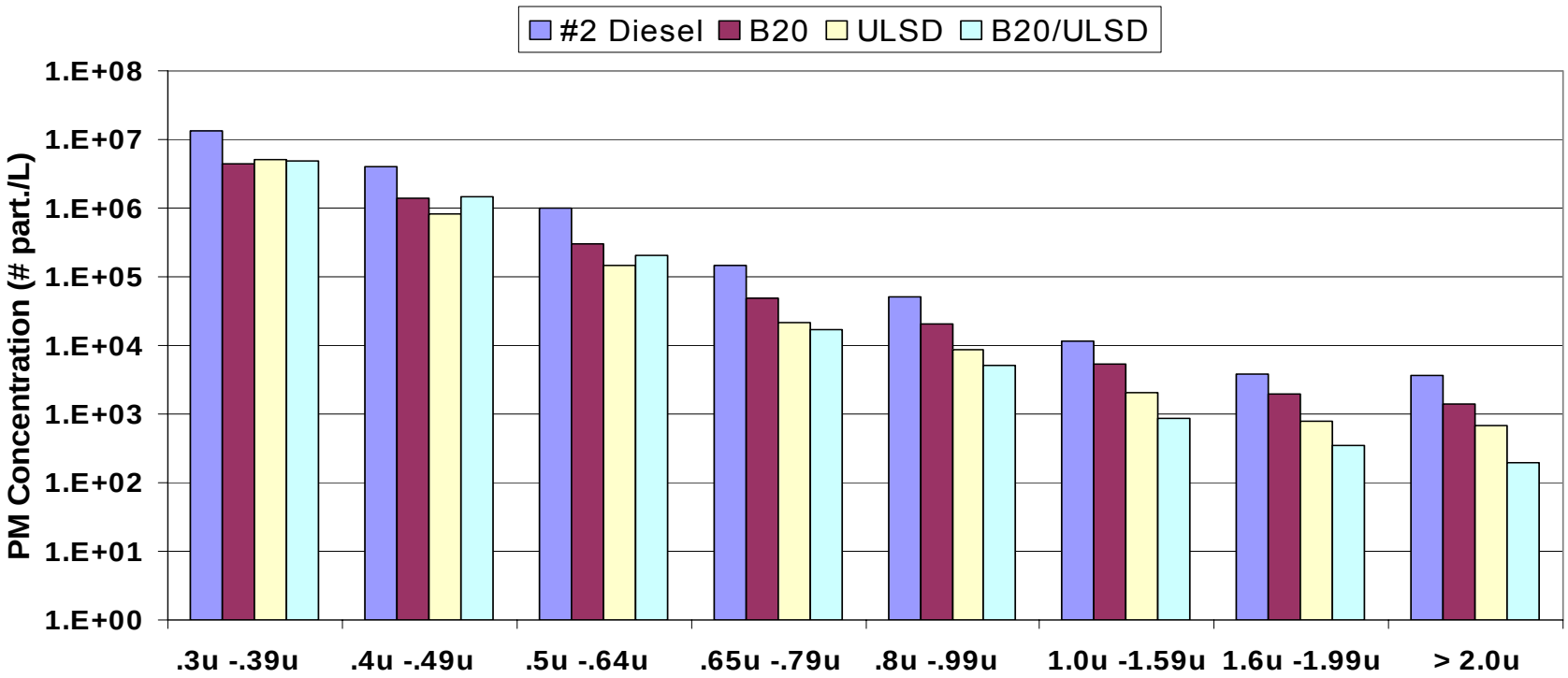
Fuel Results – T444E



Fuel Results – Cummins ISB Engine



PM Results – Cummins ISB



Thank You

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